5ESS EXCHANGE SYSTEM

Basic characteristics/Functions of the 5ESS-2000 Switch

**Overview :-**

The 5ESS-2000 Switch is a digital exchange that can serve as a local(lines), toll(trunks), tandem(lines and trunks), OSPS(operator Service Position System) or international gateway exchange, depending on the type of switch. It can serve a small community with fewer than 100 subscribers or a large metropolitan area serving more than 100,000 subscribers.

**Modular Distributed Design :-**

The 5ESS-2000 switch is a digital switching with distributed processing. Distributed processing means that multiple processors handle all call processing functions. Many processors are distributed throughout the system supported by a central processor. These distributed processors handle second-to-second decisions that must be made to process a call. Call processing, self maintenance, and testing are performed independently in each module. Processors communicate with each other via an internal digital network that links the module together.

The 5 ESS 2000 Switch hardware has three major types of equipment modules.

1. **SM (Switching Module)**
2. **CM (Communications Module)**
3. **AM (Administrative Module)**

Each module performs its assigned functions to contribute to the operation of the entire switch.

The **SM** connects all lines and trunks to the 5 ESS-2000 Switch. It performs most of the call processing functions. There can be many SMs per 5ESS-2000 Switch.

The **CM** provides communication between the SMs and the **AM**. There is one CM per 5ESS-2000 Switch.
The AM provides administration and maintenance capabilities. There is one AM per 5ESS-2000 Switch.

**Growth and Degrowth :-**

Modular architecture makes it easy to increase or decrease the capacity of the exchange. Increase in the capacity of the switch is called GROWTH. Decrease in the capacity of the switch is called DEGROWTH. The SM is the primary module for growth or Degrowth of the 5ESS-2000 switching system. Growth or Degrowth is accomplished by changing the no. of SMs in a switch or the no. of units within the SMs.

1. **SWITCHING MODULE FUNCTIONS**

**Overview :-**

All external lines, trunks and special services ckts. are terminated at the switching module. The analog & digital are converted to the digital format used inside the 5ESS-2000 Switch. The SM performs almost 95% of the call processing & maintenance functions including :

- Line & Trunk scanning
- Routine maintenance & self-maintenance
- Tone & Cadence generation
- Digit analysis
- Call routing
- Ckt. Switching
- Packet switching
- Announcements
- Call progress supervision

The SM provides many subscriber calling features including :-

- Call Waiting
- Abbreviated Dialing
- Call Diversion
- Conference Calls
One 5 ESS-2000 Switch can support as many as 192 SMs. Each SM can handle as dependent upon engg. considerations.

**TYPES OF SWITCHING MODULES**

It can be equipped with the following types of SMs :-

A) **LSM (LOCAL SWITCHING MODULE) :-**

This type of SM serves local lines, trunks, & ISDN (Integrated Services Digital Network) users. The LSM is usually referred to as the SM.

B) **HSM (HOST SWITCHING MODULE) :-**

This provides the normal LSM subscriber interfaces & also interfaces one or more RSMs (Remote Switching Modules).

C) **RSM (REMOTE SWITCHING MODULE) :-**

This type of SM is designed to meet the needs of those communities that are too small to be served by their own 5ESS-Switch in a remote area. This is done by having the RSM connected to an HSM. The RSM can be as far away as 242kms. From the host upto 4 RSMs (called a MMRSM (Multi-Mod RSM)) can be interconnected to serve 16,000 lines, 2000 trunks, or a combination of line & trunks. The RSM provides full - stand -alone capabilities, including direct trunks to other exchanges, &can be used singularly or grouped in clusters.

D) **PSM (POSITION SWITCHING MODULE) :-**

This type of SMs supports OSPS(Operator Services Position System) features.

Originally, the SMs were called IMs(Interface Modules).

**SWITCHING MODULE COMPONENTS**
SMs consists of two types:

1. The single **SMC(SWITCHING MODULE CONTROLLER)** is numbered 1 and contains the control units that are assigned specific locations within the SMC.

   - **CONTROL UNITS** :- It controls all activities within the SMs, such as Call Processing and maintenance functions.

2. An SM can have from one to four **LTP (LINE/TRUNK PERIPHERAL)** cabinets that are numbered 0,1,2,3, and 4.

   - **PERIPHERAL UNITS** :- It perform testing function and provide customers and other exchanges access to the 5 ESS-2000 Switch digital network. There are two types of peripheral units.

     # **Interface Units** :- that interface packet data, analog and digital lines, and trunks to the 5 ESS-2000 Switch.

     # **Service Units** :- that provide support as test equipment and multiport conferencing circuits.

1) **SM CONTROL UNITS** :-

   Located in the SMC cabinets are the two SM control units :-

   a) **The SMP(SWITCHING MODULE PROCESSOR)** &

   b) **The TSI(TIME SLOT INTERCHANGER)**

   These two units are combined into the **MCTSI(MODULE CONTROLLER & TIME SLOT INTERCHANGE)**, which is also referred to as the MCTU.
a) **SWITCHING MODULE PROCESSOR** :-

The SMP contains the microprocessor and memory used to perform the call processing and maintenance functions within the SM. The SMP performs five major functions:

- Control Peripheral Units.
- Performs Calls Processing.
- Performs SM maintenance.
- Initializes SM memory.
- Communicates with the AM and others SMs.

b) **TIME SLOT INTERCHANGER** :-

The second control unit in the SM is the TSI(Time Slot Interchanger). The TSI performs the time portion of the time-space-time division switching. This type of switching allows multiple inputs access to a set no. of outputs when processing phone calls.

This TSI transmits and receives peripheral time slots to & from peripheral units. Peripheral time slots contain digital call data from lines and trunks or other user data, such as from computers.

The TSI also switches data from the network side to the CM where it is routed to other SMs.

The TSI interchanges the peripheral time slots to the network time slots on two NCT(Network Control & Timing) links connecting the SM to the CM. In the reverse direction, the TSI also interchanges network time slots to peripheral time slots. The TSI also interchanges peripheral time slots between different peripheral units.

2) **SM PERIPHERAL UNITS** :- It consists of the following:

A) INTERFACE UNITS
B) PACKET SWITCH UNIT
C) SERVICE UNITS

A) **INTERFACE UNITS** :-
There are two analog interface units :-

a) **LU (LINE UNIT)**: It connects analog lines from the subscribers telephones to the 5ESS-2000

b) **ATU (ANALOG TRUNK UNIT)**: It terminates a variety of analog trunks to the digital switching network. These voice freq. trunks can be interexchange trunks, trunks to PBXs (Private Branch Exchange), trunks to announcement machine units, or local test cKts.

There are 2 digital interface units :-

a) **ISLU2 (INTEGRATED SERVICES LINE UNIT MODULE 2)**: 

It terminates both analog & digital subscriber lines. The ISLU2 is equipped in SMs that have ISDN (Integrated Services Digital Network) & its primary purpose is to provide service to the ISDN subscribers.

b) **DLTU (DIGITAL LINE TRUNK UNIT)**: 

It terminates digital trunks from other exchanges or from RSM facilities in a switch and converts T1 or PCM (Pulse Code Modulation) 2Mb/s (Megabit Per-Second) format to network time slot format.

B) **PSU (PACKET SWITCH UNIT)**:

It is a special interface unit that does not directly terminate lines or trunks. The PSU performs several miscellaneous ISDN functions:

a) . Processes ITU-T (INTERNATIONAL TELECOMMUNICATION UNION TELECOMUNICATION STANDARDIZATION SECTOR) No. 6 & 7 signaling.
b) Processes packet switched data.

C) SERVICE UNITS / SERVICE CKTS. :-

There are 5 types of service units, 3 of which are referred to as DSUs (DIGITAL SERVICE UNITS). The different types are as follows :-

a) LDSU (LOCAL DIGITAL SERVICE UNIT) :-

It has two functions :-

# To generate digital tones
# To decode digital tones

The tones generated or decoded by the LDSU can be routed to any line or trunk on a particular SM. The LDSU functionality can be provided in a variety of equipment configurations ranging from a full unit to a single ckt. pack.

b) GDSU (GLOBAL DIGITAL SERVICE UNIT) :-

Every 5ESS-2000 Switch has at least one GDSU which can provide services to any SM in the exchange. The GDSU can also be configured in a variety of ways. The GDSU has the following two functions :-

# Conference facilities
# Transmission testing

c) DSU2 -RAF/ SAS (DIGITAL SERVICE UNIT 2 - RECORDED ANNOUNCEMENT FUNCTION /SERVICE ANNOUNCEMENT SYSTEM) :-

It provides an announcement when a call is routed to a vacant code, equipment is busy, or blocking conditions exist. Other uses include OSPS features & when customised announcements are needed. SAS has more announcement capacity than its predecessors, RAF.
d) **MMSU (MODULAR METALLIC SERVICE UNIT) also called as MSU :-**

It has 3 functions :

# Metallic test access
# Subscriber line testing
# A scan & distribute function

e) **PPMU (PERIODIC PULSE METERING UNIT) :-**

Subscriber lines used in coinboxes, hostels & restaurants very often have a home meter installed. These subscribers are connected to the PPMU (or PPMU auxiliary), which injects the correct signalling to increment the home meter & provides the subscriber with an accurate measure of phone usage.

2. **COMMUNICATION MODULE FUNCTIONS**

**Overview :-**

Because of the distributed processing architecture of the 5ESS-2000 Switch, information must constantly be exchanged between processors. The CM (Communications Module) serves as the hub (focal point) for all intermodule comm. in a 5ESS-2000 Switch.

**COMMUNICATION MODULE FUNCTIONS :-**

In the switch, the AM& SMs are not directly connected to each other. The CM routes messages between each module so they all work together. The CM has four main functions :-

- Call Switching : The CM interconnects the paths between switching modules to complete telephone calls and to relay data.
- Message Switching : The CM provides paths to send information between processors to process calls, maintain records, and perform system tasks.
- Network Timing : The CM provides accurate timing and synchronisation for the 5 ESS-2000 Switch.
• Fast Pump: The CM provides resources to quickly download(pump) software, from AM to ANSM if needed.

COMMUNICATION MODULE LINKAGES: -

The AM is connected to the CM by the DSCH(Dual Serial Channel) bus. This metallic bus has two serial bit streams that receive and relay control messages.

NCT(Network Control & Timing) links are fibre optic cables that connect each SM to the CM. The NCT links carry information in a max. of 512 time slots divided between two physical links. One of the 256 time slots on each link is a dedicated control message time slot.

Each of the control time slots is used to carry intermodule control messages. The other 255 time slots per link are used to carry call data(voice samples or customer data transmissions).

Not shown on the graphic, the CLNK(Comms. link) is the hardware path between the SMP & the MSPU(Message Switch Peripheral Unit) of the CM. This is the path that carries the control time slot. Because of the redundant nature of the CM hardware, each SM has alternate CLNK paths across the switching network.

CM CABINET CONFIGURATIONS: - The CM line-up can vary in size from a minimum of two to a max. of twelve cabinets that are grown from the centre out in a mirror image. Basic cabinets 5 & 6 are always equipped and depending on the number of SMs supported, additional cabinets can be added, two at a time, starting with growth cabinets 4 and 7.

MAJOR COMPONENTS OF THE CM: -

All versions of the CM are divided into two functional units: -

1) The MSGS (MESSAGE SWITCH)
2) The ONTC(OFFICE NETWORK AND TIMING COMPLEX)

The following description is based on the most common type of CM currently in the field, the CM2.
The MSGS and ONTC are each made up of sub-units. The four major functions of the CM are performed by these hardware sub-units:

1) **MSGS** :-

   a) **MSCU** *(Message Switch Control Unit)*
   b) **MSPU** *(Message Switch Peripheral Unit)*

2) **ONTC** :-

   a) **CMCU** *(Communications Module Control Unit)*
   b) **TMSU** *(Time Multiplexed Switch Unit)*

The ONTC also includes some functional areas of the SM/SM-2000

1) **MSGS**

   a) **MSCU** :-

      It provides control over the MSPU. It passes control information to & from the AM & the other CM units; it also interprets the destination code of the control messages coming from the SMs. The MSCU directs the information flow between processors in the AM & the SMs.

   b) **MSPU** :-

      It processes control messages & switches them to the AM or SMs. The MSPU can be regarded as a series of mail boxes in which messages are deposited before they are routed. Each SM has assigned capacity in the MSPU, & control messages are transferred under direction of the MSCU.

2) **ONTC**

   a) **CMCU** :-
It provides timing for the system & provides control for the TMS (Time Multiplexed Switch). It also provides the connection path between the TMS & AM, MSCU, & MSPU.

b) **TMSU:**

It terminates the NCT links & switches both data & control time slots between the links. The hardware units of the TMS perform the actual switching of the calls between trunks.

No single unit of the CM is more important than the others. Because of the interconnecting paths, all the parts are necessary. Because of this, virtually all parts of the CM are duplicated.

**TYPES OF COMMUNICATION MODULES:**

There are four types of CMs in the field:

1) **CM1:**

This was the earliest type of CM. It operates much the same as the CM2, but is of an older vintage.

It is made up of a max. of 4 cabinets of equipment. It is capacity limited (32 SMs) & has been replaced nearly everywhere with CM2.

2) **CM2:**

Most common today, the CM2 can support up to 192 SMs, or a mix of SMs & SM-2000. It is made up of a min. of 2 cabinets, but can grow to as many as 12 when needed.

3) **CM2 with QLPS (QUAD LINK PACKET SWITCH):**

This is a modification of the CM2 which adds additional control message capacity. It is available for offices with high capacity SM-2000s. It is nearly identical to the CM2, with additional hardware units.
This unit is intended for small office applications & supports only a limited no. of SMS. It is made up of a 2 shelves, which can reside in an SM cabinet.

3. **ADMINISTRATIVE MODULE FUNCTIONS**

**OVERVIEW:**

In the 5ESS-2000 Switch, the AM (Administrative module) is a switch equipment module which has the overall control of the entire 5ESS-2000 Switch. The AM controls the CM & communicates with all the SMs (through the CM). The AM monitors itself and the CM for malfunctions.

**ADMINISTRATIVE MODULE FUNCTIONS:**

It has a min. of 1 cabinet & can have a max. of 3 cabinets. The AM performs resources allocation & processing functions that are done more efficiently on a centralised basis such as:

- Call routing for intermodule & intramodule calls
- Administrative data processing/billing data
- Traffic measurement reports (system performance reports)
- Memory management
- System maintenance
- Maintenance file records of changes to the system software release
- Personnel interface/system monitoring
- Allocating trunks for call processing

**ADMINISTRATIVE MODULE COMPONENTS:**
There are three main units located within the AM :-

* CU (Control Unit )
* IOP (Input / Output Processor )
* DFC (Disk File Controller )

The CU monitors overall system operation .

The IOP interfaces with the MCC (Master Control Center ), ROP (Receive Only Printer ) & other peripheral devices .

The DFC controls the TD (Tape Drive ) & DD (Disk Drive ).

* CONTROL UNIT :-

The control unit consists of two subunits :-

A) The CC(CENTRAL CONTROL )
B) MM(MAIN MEMORY)

A) CC(CENTRAL CONTROL) :-

It has six major functions :-

@ - Executes Programs - The CC contains logic circuits that execute step-by-step instructions to control the operation of the AM processor.

@ - Executes Program requests - responds to requests from the SM and from maintenance personnel.

@ - Process administrative data - compiles report information and prints reports periodically.

@ - Monitors system operation - maintains a log of equipment status and a list of OOS(out-of-service) equipment.
@ - Updates Duplicates CU - communicates with duplicate standby CU to keep its m/m up-to-date.

@ - Manages data transfer - Controls m/m transfer between its own m/m, its hard disk, & the microprocessor that serve the peripheral units in the IOP.

B) MM(MAIN MEMORY) :-

The MM stores program instructions and data. The MM stores the instructions and other data needed by the processor to process calls, collect administrative information, and perform system maintenance.

AM PERIPHERAL COMPONENT FUNCTIONS :-

DISK FILE CONTROLLER :-

The DFC is responsible for interfacing with the SCSI(Small Computer System Interface) peripheral devices, such as the disk and tape drives.

SCSI DISK DRIVE :-

The functions of the SCSI(SMALL COMPUTER SYSTEM INTERFACE) disk drive are as follows :-

- Stores copies of software used in the 5 ESS-2000 Switch --if data in the MM is lost, it is restored from the disk copy.
- Stores hardware configuration data – information on the disk defines the configuration of hardware, and line and trunk termination.
- Stores billing data – disk has a temporary area for billing data. The data is stored until it is requested by the host collector or dumped to tape.

TAPE DRIVE :-

The tape drive is a backup for information stored on disk. The tape drive may be either a conventional
computer nine track tape drive or a DAT (DIGITAL AUDIO TAPE). Data can be transferred from tape to disk or from disk to tape. Billing data for the Revenue Accounting office is also stored on tape.

**INPUT/OUTPUT PROCESSOR :-**

The IOP is the interface for other peripheral devices used by the switch, such as maintenance Interfaces (MCC and ROP), datalinks and alarm signaling.

**MASTER CONTROL CENTER) :-**

The AM maintains up-to-date records on system operations and knows the status of all hardware units throughout the exchange. This information is available to maintenance interface called the MCC is the main local work station for maintenance personnel. It uses a full-color video display terminal as a window to the system. By entering poke commands selected from menus on the terminal screen or machine language commands selected from the 5 ESS-2000 Switch Commands And Reports Manual, maintenance personnel can diagnose equipment, remove equipment from service, restores equipment to service, test lines and trunks, and modify the database and service features for customers. The ROP (Receive-Only-Printer) provides a printed copy or reports from the MCC.

The primary functions of the MCC are to provide the following :-

1) Visual displays of system status and alarm information.
2) The means to control, test, and reconfigure the system.
3) The means to manually recover the system.
4) Access to exchange data.

**CALL PROCESSING :-**
OVERVIEW :-

It provides a fundamental description of line-to-line and trunk-to-trunk calls in a 5 ESS-2000 Switch.

CALL PROCESSING STAGES :-

There are five functional steps of call processing, including the location of the originating and terminating equipment. These steps are:

@ - **Origination** :- It begins when the subscribers line goes off-hook or when an incoming trunk is seized.

Origination receives the incoming digits, selects the digit analysis tables, and determines the screening information for this call.

@ - **Digit Analysis** :- It interprets the digits that it receives from origination, selects a destination for each call, and passes the dialed digits to routing.

@ - **Routing/Screening** :- Routing uses the destination information from digit analysis and screening information from origination to select the terminating trunk group or line. The type of charges associated with this call is determined and sent to charging.

@ - **Charging** :- It uses the charging information from routing to expand the charging data into a format useable by the Call Accounting process. There are various types of call accounting features; from basic AMA records to Fee Calculation.

@ - **Termination** :- The last step in call processing is termination. Termination process are different for calls destined for lines and calls destined for trunks.
# Trunk Termination - an idle trunk member of the trunk group is selected based on a pre-determined pattern. After selection, digits are outpulsed to the distant office.

# Line Termination - the line identified in routing is checked to determine if the line has any special features. Ringing is applied to the line if applicable or the special feature is activated.

**CALL PROCESSING :-**

The most important function of a 5ESS-2000 Switch is to process subscriber calls. Subscriber’s calls can be classified as line-to-line, line-to-trunk, trunk-to-line or trunk-to-trunk. A line-to-line call is a call that starts on a line served by a 5ESS-2000 Switch and terminates to another line served by the same switch. The SMs involved in the call will perform almost 95% of the call processing functions.

During a line-to-line call, the originating SM detects when a subscriber’s telephone receiver has been picked up. The SM provides dial tone and then removes dial tone when the first digit is dialed. It then collects & analyses the dialed digits. Next, the SM sends a request to the AM for a call path. The terminating SM locates the subscriber line for the line-to-line call & provides ringing.

**BASIC CALL TYPES**

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When the AM has been selected an available path, it alters the CM to set up a link between the SMs.

The CM provided call paths between SMs & carries all internal system communications.

The functions of the SM, AM, & CM in a trunk-to-trunk call are basically the same as the line-to-line described above except that the originating SM detects a trunk seizure rather than a subscriber picking up the receiver. Also, the terminating locates an available trunk instead of a line.

If a call involves both a line & a trunk (line-to-trunk, trunk-to-line), the scenarios above may differ slightly. Also, the scenarios may differ depending on the applications supported by your exchange.

Line-To-Line calls can be of two types:

1) **INTRA-SM** - where both subscriber lines (originated & terminated) are connected to the same SM. This doesn’t require use of CM.

2) **INTER-SM** - where both subscriber lines are connected to different SMs. This requires use of CM.

**5ESS-2000 SWITCH APPLICATIONS** :-

**OVERVIEW** :-

The 5 ESS-2000 Switch was designed with a flexible modular approach with regard to both software and hardware, allowing for digital services, capabilities that support many applications. Current applications supported by the system are follows:
1) Local Exchange
2) Toll Exchange
3) Gateway Exchange
4) OSPS(Operator Service Position System)
5) ISDN(Integrated Services Digital Network)
6) STP(Signalling Transfer Point)
7) SSP(Services Switching Point or Action Control Point)
8) MSC(Mobile Switching Center or Wireless)

1) **LOCAL EXCHANGE** :-

   Local subscriber’s gain access to the local exchange through lines. The exchanges switches a call from an internal subscriber to another subscriber directly or through a trunk ckt. to a subscriber in another exchange. A trunk ckt. (or trunk) connects a local exchange to another local exchange or toll exchange. A local exchange has a high % of lines & a small percentage of trunks.

2) **TOLL EXCHANGE** :-

   A toll exchange (or trunk tandem exchange) connects a local exchange to another local exchange or to a gateway exchange. A toll exchange has a high percentage of trunks & a low percentage of lines, if any.

3) **GATEWAY EXCHANGE** :-

   There is one international network consisting of interconnected gateway exchanges. Each country (A & B) in this network has its own gateway exchange, an international toll exchange. International calls enter & leave the country from this gateway exchange.

4) **OPERATOR SERVICE POSITION SYSTEM** :-
The 5 ESS-2000 Switch offers automatic operator services via the OSPS (Operator Service Position System). OSPS applications are directory inquiry and Traffic Assistance. Directory Inquiry allows operators to supply directory numbers to calling subscribers. Traffic Assistance allows operators to complete calls and respond to inquiries for subscribers. The OSPS uses a special SM called a PSM (Position switching Module).

5) INTEGRATED SERVICES DIGITAL NETWORK :-

Another type of 5 ESS-2000 Switch applications is the ISDN (Integrated Services Digital Network).
ISDN offers new voice & data services, & allows features such as OSPS. ISDN also allows voice, data, & signalling information to travel over the same digital subscriber line. It lets all three components use the same transmission path simultaneously.

Two people with ISDN can make phone calls & use their computer terminals to access one or more computers at the same time. ISDN service is fully compatible with POTS service. ISDN service requires specific ISDN hardware & software in the SM.

6) SIGNALING TRANSFER POINT :-

The STP (Signalling Transfer Point) is an exchange application that sends signalling messages on their way to the proper destination over a different path than the associated voice ckt. STPs are associated with the CCS7 (Common Channel Signalling 7). This application allows for more efficient use of trunk circuits.

7) SERVICE SWITCHING POINT :-

The SSP (Service Switching Point), also called ACP (Action Control Point), is a 5ESS-2000 Switch.
application that is part of an IN (Intelligent Network) configuration. IN technology allows the introduction of advanced services, primarily through software updates, with minimal network rearrangements & minimal service disruption. The SSP is able to recognise an incoming IN call, process it, or request call handling instructions by use of a remote database that is accessed by many switches in the IN.

8) **MOBILE SWITCHING CENTER** :-

The MSC (Mobile Switching Center) performs the switching functions for wireless systems. This 5ESS-2000 Switch application monitors subscriber mobility, manages resources, communicates with other networks, performs call routing & control functions. The MSC configuration includes an AM, CM, SMs, WGSM (Wireless Global Switching Module), at least one WSM (Wireless Switching Module), & possibly a WRSM (Wireless Remote Switching Module) or multinode.

**MAINTENANCE TOOLS** :-

**OVERVIEW** :-

The MCC (MASTER CONTROL CENTER), CUSTOMER DOCUMENTATION, TLWS (TRUNK AND LINE WORKSTATION) function, & RC/V (RECENT CHANGE AND VERIFY) function are all essential tools for 5ESS-2000 Switch maintenance.

**MCC (MASTER CONTROL CENTER)** :-

The MCC is the primary communication link between maintenance personnel & the 5ESS-2000
Switch for performing the maintenance functions. In smaller exchanges, it is possible to have only the MCC terminal. Larger exchanges will need more terminals & printers.

- **TLWS (TRUNK AND LINE WORKSTATION)** :-

  The function of the TLWS is to test the lines & trunks in an exchange. This function may be invoked from terminals located within the exchange (MCC) or from remote maintenance facilities.

  The term TLWS can be used to reference the TLWS function (software) or the terminal used to access the TLWS function (hardware). A terminal is defined for use as a TLWS in the switch’s ECD database.

**TLWS Function :-**

The TLWS function is used to :-

@ Remove & restore service to subscriber lines & trunks for testing.

@ Test subscriber lines.

@ Initiate operational & transmission tests on trunks.

-- Operational tests check the ability of a trunk to complete a call.

-- Transmission tests measure the quality of signals being reserved by a trunk.

**BELTLINE CIRCUIT :-**

Sometimes tests are performed from locations other than the MCC. For instance, during installation, difficult fault conditions might occur in the SM (Switching Module), that can be located a distance from the MCC. This may cause some inconvenience for maintenance personnel, since they must walk back and forth between the SM and the MCC. To avoid that, the ESS-2000 Switch frames (cabinets) are equipped with connectors to allow the maintenance personnel to connect portable I/O devices, such as a TTY or a terminal with keyboard near the SM. This feature is called the **beltline circuit**.
Beltline jacks (connectors) are multiplied at optional frame locations around
the exchange making the circuit accessible from several points. They are
mounted on a jack strip located between the fuse panels at the top of the
equipment frames. Although the beltline jacks can be multiplied to each SM,
a maximum of two beltline circuits may be used at the same time. They are
referred to as Beltline A & Beltline B. The beltline jacks are wired to the
peripheral controllers in the IOP(Input/Output Processor)Unit.

**RECENT CHANGE AND VERIFY :-**

The RC/V(Recent Change and Verify) function enables you to view and
alter the 5 ESS-2000 Switch databases, and is accessed from the
MCC(Master Control Centre), OMC(Operation & Maintenance Center),
STLWS(Supplementary Trunk and Line Workstations), or from optionally
equipped RC/V terminals. The MCC and the OMC have access to all RC/V
functions. Individual terminals, however, may be restricted to specific
functions.

RC/V provides the capability to view and alter the databases in the 5 ESS-
2000 Switch.

RC/V function has the following two modes :-

- **RC(Recent Change) mode** provides a way of accessing and changing the
  system databases to reflect changes in customer services or system
  capabilities.
- **V(Verify) mode** provides the ability to view, but not change, database
  contents. This allows one to verify that the correct changes were made.

**OCB-283 EXCHANGE SYSTEMS**

1) Salient Features :

- **OCB** stands for **ORGAN CONTROL BHERSION**
- Digital switching system developed by M/s CIT ALCATEL of France.
- Digital switching system with single “T” stage.
- OMC & S/N are duplicated.
- Variety of services provided are
i) Basic Telephony
ii) ISDN
iii) Mobile
iv) Video text &
v) others

• It supports different types of signalling systems:
  i) Decadic
  ii) MF
  iii) CAS
  iv) CCITT No.- 7

• Max no. of junctions may be 60,000
• Only 35 types of Cards (excluding CSN)
• Space requirement is very small
• Environmental requirement is not very stringent
• Traffic handing capacity is 8,00,000 BHCA
• Automatic fault recovery feature & remote monitoring
• Operating system used is RTOS (Real Time Operating System)
• Language used is CHILL

2) MAJOR UNITS OF OCB SYSTEM:
2.1) CSN (SUBSCRIBER CONNECTION UNIT):
It is CSNL for local subscriber’s & it is CSND for remote subscriber’s. A CSN basically consists of 1 Basic Rack & 3 Extensions Racks. Capacity of CSN is 5000 max. Subscriber’s may be Analogue & Digital.
  A) TABAS - For Ordinary sub. -16 sub. per card.
  B) TABAE - For home metering - 16 sub. per card.
  C) TABAN - For ISDN subscriber’s - consumes 16 ports

2.2) TRUNK AND JUNCTION CONNECTION UNIT (SMT):
It is the interface between the switching network & junctions from other exchanges (or remote sub-connection unit)

2.3) SWITCHING MATRIX (SMX):
It is a single stage “T”. It is made up of Host Switching Matrix & branch selection & Amplification Function, SMX is duplicated.

) AUXILIARY EQUIPMENTS CONTROL STATION (SMA):
It contains ETA & PUPEETA consists of freq. Receiver/Generator, conference calls CCTS. Tone Generators - PUPE Some DOES functions of CCITT No. 7.

2.5) Control Units(SMC) : There are six control units as under:

a) Multiregister(MR) - for establishing and releasing of calls.

b) Transistor(TR) - for storing Exchange database.

c) Charging Unit(Tx) - for carrying out charging jobs.

d) Marker(MQ) - for performing connection & disconnection of subscriber.

e) CCS-7 Controller(PC) - for carrying out routing & traffic management functions.

f) Matrix System Handler(GX) - for monitoring connection in S/N

2.6) Operation & Maintenance Unit(SMM) :

It is OMC for supervising functions of different units and for taking suitable actions at the event of faults. It uses two identical microprocessors Motorola-68030. There are two magnetic disks each of capacity 1.2GB for various storage. One streamer drive of 525MB is provided for initialisation and backup etc. There are two magnetic tape drives for transferring charging data for billing etc subsequently. SMM is duplicated.

OMC (OPERATION AND MAINTENANCE CENTER) :

It is a general purpose computer called MITRA-225 supplied by M/S-CIT Alcatel, France through M/s.ITI Ltd. One complete system consists of 1 CPU unit, 4 Magnetic Tape Unit (MTUs) & 1 Hard-disk drive. 1 spare system consisting of 1 CPU unit, 1 Magnetic Tape Unit & 1 Hard-disk drive used as a stand by system.

REQUIREMENT OF OMC :

The normal call connection in E-10B exchange is independent of OMC. The subscribers will not be affected if the OMC fails. This OMC system is required by the mtc, staff for feeding/retrieving information to/from E-10B exchange. The following tasks will not be possible to carry out, if the OMC fails:

i) Interrogation of sub. data like meter reading, status of phone-plus facility etc.
ii) Modification of sub. data like creation/ addition / suppression of new sub. line , barring/ restoring of STD service, providing/ deleting phone - plus facilities etc 

iii) Interrogation of Exchange data like status of all the units of exchange , status of PCM links, ckt. group status, traffic data etc

iv) Monitoring of exchange data, sub-data, like periodic traffic report, junction report, observation data, print out of fault messages generated by various units, repair of various diagnostics, testing of sub. lines, testing of junction etc.

v) Retrieval Of Valuable Data :- Preparation of bimonthly meter- reading tape (TAXIL Tape ), saving of memory data of control units (MMSU Tape ) & preparation of system tape.

BASIC CONSTITUENTS OF THE OMC SYSTEM :

The pictorial view of Mitra-225 OMC computer is shown in the fig. The complete computer system is covered in 4 cabinets as shown below :-

1 ) CPU UNIT :- It consists of the following PCBs (Printed Ckt. Board )

- CPU Power Supply AL01
- Real Time Clock RTC
- AMC Coupler EP-59
- Magnetic Tape Coupler OP-50
- Magnetic Tape Coupler OP-50
- Disk Coupler NESSIE- Adaptor
- Disk Coupler NESSIE- Operator
- Watch -dog Timer EP-63
- Asynchrours Coupler LP-55

The No. of LP-55 PCBs may vary from 1 to 4 depending upon no. of terminals connected with this system. 1 LP-55 can cater 8 peripherals , for more than 32 peripherals , extension shelf is to be used.

- Eight - External Interrupt EP -54
- MAE Coupler CP-51
- CPU TN-51
- 256 kb Main Memory ME-03

2 ) MAGNETIC TAPE UNIT (MTU ) OR BM (BAND MAGNEIC ):-

The MTUs are used as auxiliary storage device . There are total 5 Magnetic tape units, out of which 2 MTUs are provided with Formatter PCB & designated as BM-0 (Mtce) & rest of the 4 i.e. BM-0 , BM-1 , BM-2 , BM-3 are used for normal system working . The Magnetic Tape Unit BM-0
is of more importance because it controls rest of the 3 drives will not work. In such event we have use BM-0 ( Mtce ) in place of BM-0 ( service ). The magnetic Tape Units are used for the following functions :-

- Storing Detail - Billing Messages ( GTDT Tape )
- Storing fault & anomaly messages ( OFFA Tape )
- Preparing subscriber’s meter - reading Tape ( TAXIL Tape )
- Preparing control units m/m data Tape ( MMSV Tape )
- Preparing system Tape ( System Tape )

VARIABLE Types OF MTUs USED IN THE SYSTEM :
With the fast technology upgradation, everytime we find new type/model of magnetic tape unit. Presently, 3 types of MTUs are available at different OMC sites in India:
1) PERTEC type - Made in USA
2) DDF type - Made in France
3) DDF- PERTEC type - Made in France

To save the detail Billing Messages, when the OMC fails, 1 mag. Tape unit (BM-0) is provided in DSF rack of each E-10B exchange. The DDF type & DDF- PERTEC type microprocessor based mag. tape units used in OMC as BM-0 are fully compatible with the DDF or DDF-PERTEC Type BM-0 used in DSF rack.

DISK UNIT UD-80 :
This is also used as auxiliary m/m for MITRA-225 Computer. It plays a vital role in man-m/c dialogue. The system & application data of different E-10B exchanges connected, with the OMC are stored in the disk drive. The data storage capacity is 80 mega byte. Out of the 2 disk drivers, 1 is connected to service CPU & the other is kept as standby disk.

In earlier supplies of MITRA-225, the disk packs inside the OD-80 disk drive; removable disk pack and fixed disk pack and fixed disk pack. All the useful data are stored an fixed disk pack.

Two Filters :
One prefilter and one absolute filters are used in UD-80 disk drive to provide a dust-free environment in disk area. Periodic clearing of pre-filter
and change of absolute filter is a must for fault free operation of the UD-80 disk drive.

Possibility of Head crash due to Dust:

The diagram below depicts how the head crash can occur in disk due to presence of various types of dust particles on disk surface.

By way of indication, we are showing below the comparative sizes of some pollutants and the height of the head.

SERVICE TERMINAL MAE:

The service terminal MAE is used as computer console keyboard for direct dialogue with computer. OMC system is initialised through this terminal. There are two MAE provided, one for service unit & other for standby system.

Other Peripherals:

- Tele Type Writer(TTY)
- Video Display Unit(VDU)
- Printer

These peripherals are the media through which man-machine dialogue takes place. The no. of TTY/VDU/IR depends on No. of exchanges connected, size of each exchange, no. of fault controlposition in test rooms. As mentioned earlier, 8 terminals can be connected to one LP-55 PCB in CPU unit. For more than 4LP-55 PCBs(i.e for connecting more than 32 terminals) extension shelf has to be installed to accommodate more LP-55 PCBs. These TTY/VDU/IR are located in exploitation room or test room. For shorter distances(about 100ft), these peripherals can be directly connected to OMC. Use of peripherals at distant places require MODEM. These MODEMS are installed in BMO rack in the OMC room. The TTYs work at 300 Bauds speed while VDU & IR work at 1200 Baud speed.

WHETHER REGULAR MAINTENANCE OF MITRA- 225 OMC SYSTEM REQUIRED:

As most of the peripheral devices are of electromechanical type, hence periodic checking for their wear and tear and cleaning is also required. The
Mtce schedule for the OMC & peripherals to be carried out by exchange Mtce staff. These Mtce tasks should be performed timely to ensure fault-free operation and long life of peripherals. The details of tasks carried out by RMC team during & monthly periodic Mtce.

Each OMC site has been supplied with one DELSEY TOOLKIT, Test Tapes called SEMS tape, SKEW tape, MTCIT tape and spares and consumerable. These items are used for testing the CPU PCBs, MTUS, Disks and other peripherals.

POINTS TO BE CHECKED DURING INSPECTION OF MITRA-225 OMC SYSTEM:

<table>
<thead>
<tr>
<th>POINTS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Whether OMC System is working normal without any link failure problem?</td>
<td>1) There should not be frequent link failure problem.</td>
</tr>
<tr>
<td>2) Are there frequent TRAP messages or DISC Access Error messages on MAE?</td>
<td>2) For a reliable system no such messages should come.</td>
</tr>
<tr>
<td>3) How many units of OMC are down?</td>
<td>3) Whenever any MTU-01 &amp; /or UP-80 disk is faulty, immediate action should be taken to get it repaired.</td>
</tr>
<tr>
<td>4) How many OMC PCBs of CPU rack are pending faulty?</td>
<td>4) It should be reported to RMC.</td>
</tr>
<tr>
<td>5) Whether exchange mtce, staff are properly carrying out mtce activities as per DOT guidelines?</td>
<td>5) These should be carried out as prescribed by DOT.</td>
</tr>
<tr>
<td>6) Whether 6 monthly periodic mtce is being carried out by RMC team? Absolute filter of UD-80 disk driven has been changed or not.</td>
<td>6) Normally, after every 6 months, the absolute filters of both UD-80 disk drives has to be replaced by new one to avoid head-crash &amp; disk failure.</td>
</tr>
<tr>
<td>7) Whether all OMC activities are being properly recorded in “OMC mtce log book”.</td>
<td>7) All activities should be recorded in proper format as suggested by DOT.</td>
</tr>
<tr>
<td>8) Whether sufficient no. of spare mag. tapes are available?</td>
<td>8) A min. 36 mag. tapes of good quality should always be available (for 1 OMC + 1 Exchange).</td>
</tr>
<tr>
<td>Question</td>
<td>Answer</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>9 ) Are the mag. tapes properly stored in a cupboard &amp; records of their use maintained in register?</td>
<td>9 ) Mag. tapes should be stacked one over others, instead they should be properly arranged in well protected cupboard. A record should be maintained to identify much used tapes for replacement.</td>
</tr>
<tr>
<td>10 ) Whether all the staff on duty are able to “Initialise the OMC” &amp; opening of mag. tape for GTDT / OPFA?</td>
<td>10 ) All mtce staff of JTO level &amp; above should at least know OMC initialization &amp; mag. tape operation.</td>
</tr>
<tr>
<td>11 ) How many peripherals TTY/ IR/ VDU are faulty?</td>
<td>11 ) Fault should be localized by exch.-staff &amp; reported to RMC.</td>
</tr>
<tr>
<td>12 ) Whether all the tools available in DELSEY TOOL KIT?</td>
<td>12 ) If any tools are missing/ lost, the same should be arranged immediately.</td>
</tr>
<tr>
<td>13 ) Whether MMSU tape is being prepared every week?</td>
<td>13 ) The MMSU tape should be prepared at least once in a week for each exch. Connected to OMC &amp; should be tested for loading of data in control unit from DSF once in a month.</td>
</tr>
<tr>
<td>14 ) Whether proper environmental conditions are maintained in OMC room?</td>
<td>14 ) Relative humidity; temp. &amp; dust free environment should be maintained for proper &amp; fault free operation of OMC &amp; peripherals.</td>
</tr>
</tbody>
</table>

**ARRANGEMENT OF PASSWORD AND GROUPING OF COMMANDS:**

1) There are nearly 320 commands available in E-10B system for performing various functions. These commands are grouped & put into 16 different classes. Any class of command can be put in password for protection. There is a complete flexibility regarding arrangement of commands in different classes in E-10B exchanges. Whatever has been arranged by the installer either some is being followed or some DEs are arranging commands as per their convenience. It is also noticed that in some exchanges, some important commands are not guarded by password.

It has further been noticed that it is possible to prevent incrementing of subs. meter reading during STD call by entering certain commands are possible misuse of this deficiency in this system cannot be avoided with the
intention of mal-practice. This deficiency in the system has already been brought to the notice of TEC for working out suitable preventive solution.

2) Till the time TEC is able to bring out suitable solutions to streamline the arrangement of password in E-10B exchange a committee was constituted by MTNL, Bombay & RMC, Bombay.

EWSD EXCHANGE SYSTEM

Introduction :-
After years of being treated as a luxury, telecommunications has come into its own in the eighth Plan. The Department of Telecommunications has announced ambitious plans for the addition of 7.5 million lines to the existing 5.8 million by the end of the 8th plan (1992-97) as compared to only 3.2 million in 1982-92.

To bridge the gap between the supply and demand DoT invited a tender for 200,000 lines of switching equipment on Rupee payment. In the industrial policy of July 1991, Telecom. equipment was delicensed and through open to foreign investments. Consequently six new technologies were planned to be validated. These foreign suppliers set up their validation exchanges, each of 10,000 lines capacity (including two RSUs of 2K each), at different places, e.g. EWSD of Siemens (Germany) at Calcutta, AXE-10 of Ericsson (Sweden) at Madras, Fetex-150 of Fujitsu (Japan) at Bombay, OCB-283 of ALCATEL (France) at Delhi etc.

Three new Digital Switching Systems, i.e., EWSD, AXE-10, Fetex-150, which got validated first, were inducted in the Indian Telecom. Network & three lakh lines were imported from these three suppliers. In addition 3.5 lakhs lines were also imported on lease basis from these suppliers. Subsequently four more switches, i.e., OCB-283 of ALCATEL (France), 5ESS of AT&T (USA), System-X of GPT (UK) and NEAR-61E of NEC (Japan) also got validated.

EWSD is one of the two technologies selected for TAX and is also the technology for Intelligent Network and Mobile Communication.

**SYSTEM FEATURES** :-

EWSD Digital Switching System has been designed and manufactured by M/s Siemens, Germany. The name is abbreviated form of German equivalent of Electronic Switching System Digital EWSD switch can support maximum 2,50,000 subscribers of 60,000 incoming, outgoing or both way trunks, when working as a pure tandem exchange. It can carry 25,200 Erlang traffic and can withstand 1.4 million BHCA. It can work as local cum transit exchange and has CCS No..7, ISDN and IN capabilities.

**SYSTEM ARCHITECTURE** :-
The main hardware units of an EWSD Switch are as under:

1. **Digital Line Unit (DLU)**: A functional unit on which subscriber lines are terminated.

2. **Line/Trunk Group (LTG)**: Digital Trunks are connected to LTGs. The access function determined by the network environment are handled by DLU and LTG.

3. **Switching Network (SN)**: All the LTGs are connected to the SN which interconnects the line and trunks connected to the exchange in accordance with the call requirement of the subscribers. CCNC and CP are also connected to SN.

4. **Co-ordination Processor (CP)**: It is used for system-wide coordination functions, such as, routing, zoning, etc. However, each subsystem in EWSD carry out practically all the tasks arising in their area independently.

5. **Common Channel Signalling Network Control (CCNC) Unit**: This unit functions as the Message Transfer Part (MTP) of CCS-7. The User Part (UP) is incorporated in the respective LTGs.

Block diagram of EWSD is given in fig.1. It also shows that the most important controls are distributed throughout the system. This distributed control reduces the coordination overheads and the necessity of communication between the processors. It results in high dynamic performance standard.

For inter-processor communications, 64 kbps semipermanent connections are set through SN. This avoids the necessity for a separate interprocessor network.

**SUBSCRIBER / ADMINISTRATION FACILITIES IN EWSD**:

1. **Rapid call set up**:
   - Abbreviated Dialing
   - Hotline Immediate
   - Hotline with Time Out

2. **Call Restriction Services**
- O/G Restrictions
- Administration Controlled
- Subs controlled
- I/C Barring

3. **Absent Subscriber Services**
   - Immediate diversion
   - Diversion on no reply
     - to operator
     - to a number
     - to announcement

4. **Call Completion services**
   - Diversion on busy
   - Call Waiting
   - Call priority (originating & terminating)

5. **Multiparty services**
   - Conference call
   - Tele-meeting

6. **Alarm call booking :-**
   - Casual
   - Regular (number of consecutive days)

7. **Services to PBX**
   - Direct dialing in (for different PBX capacities)
   - Line hunting

8. **Miscellaneous Services**
   - Malicious call identification
     - All calls
     - Special subscriber signal

9. **Call charge services :-**
   - Separate counters for Local Call charges, STD/ISD calls charges,
   Number of calls, Service
   activity charges and Service usage charges
   - Transmission of meter pulses
   - Preventive meter observation (adjustable threshold)

**SYSTEM DATA**

Call -handling capacity  No. of Subscriber lines  -  max. 250
000
No. of Trunks  -  max. 60
000
Switchable traffic - max. 25
200 E

Supply Voltage

-48 V nominal direct voltage

Clock accuracy

Maximum relative frequency deviation:
plesiochoronous 10 \times 10^{-9};
synchronous 10 \times 10^{-11}

Signaling systems

All conventional signaling systems,
e.g. CCITT R2, No.5, No. 7

Analog subscriber line & trunk accesses

Various loop and shunt resistance possible.
Push-button dialing, Multifrequency.
Signaling to CCITT
Recommendation Q.23
Rotary dialing: 5 to 22 pulse/s

ISDN accesses

Basic access: 160
kbps (2B+D+sync.)

\[ B = 64 \text{ kbps}, \ D = 16 \text{ kbps} \]

Primary rate access: 2048
kbps (30B+D+sync.)

Digital trunk accesses

2048 kbps

Traffic routing

Per destination max. 7 high-usage routes and one final route Sequential or random selection of idle trunk of a trunk group
Number of trunk groups per exchange:
Max. 1000 incoming and
Max. 1000 outgoing and
Max. 1000 bothway

Call charge registration

Periodic pulse metering,
AMA : Automatic Message Accounting or Detailed Billing (CAMA, LAMA)
IARSTAT (Inter Administration Revenue accounting and Statistics)

Max. 127 zones
Max. 6 tariffs per zone
Tariff switchover possible in 15-minute timing intervals
Transmission of communication data to computer center (output on tape also possible)

Space requirements
Example: Exchange for 24000 lines units approx. 100 meter square.

Environmental conditions
Ambient temperature : 5 degree centigrade to 40 degree centigrade
Relative humidity : 10% to 80%